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The Acoustic Performance of 3D Printed Multiple Jet Nozzles with Different Configurations

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Abstract: This work investigated multiple jet nozzles with various geometrical shape, number of exits, and material on reducing noise radiated from jet flows. Nozzles are categorized in two groups with few and many exit numbers, each with various exit shapes, slot and circular, and geometry. Firstly, nozzles are designed and then fabricated by a 3D printer, Form Labs, Form2USA, with polymeric resin. Also, the nozzle with the most noise reduction made of stainless steel. Noise and air thrust were measured at three air pressure gauges, 3, 5, 7 BAR and directions from nozzle apex, 30°, 90°, 135°. Nozzles with slot exit shape made of both plastic and stainless steel revealed the most noise reduction among all nozzles with few exit numbers, nearly 11–14 dB*(A)* and 11.5–15 dB*(A)*, respectively. On average, slotted nozzle noise reduction was nearly 5–6 dB*(A)* more than finned nozzle. However, nozzles with more exit numbers, finned and finned-central exit, illustrated much more noise reduction than nozzles with few exit numbers, by almost 16–18 dB*(A)*, they represented similar sound. All tested nozzles and open pipe demonstrated equal air thrust at each pressure gauges. The nozzles with slotted exit shape, either plastic or stainless steel, can provide reasonable noise reduction in comparison to other configuration with few exit numbers. In contrast, nozzles with more exit numbers demonstrated the most noise reduction.

Keywords: Jet noise; multiple jet nozzle; noise reduction; 3D design; exit shape; nozzle geometry

1 Introduction

Noise is considered as the most common occupational exposure around the world. This physical hazard is accompanied with numerous psycho-physiological problems on the workers [1, 2]. Jet noise, also called aerodynamic noise, is generated by venting high pressure air, steam, process gas, and liquid into atmosphere [3]. Manufacturing jet noise likely ranks third as a major cause of hearing damage after impact and material handling noise [4]. Compressed air guns, as a single jet nozzle, can produce sound pressure levels over the range of 88.8–105.2 dBA. Numerous industrial processes apply compressed air jet flows for tasks like cleaning, shooting, drying, moving, cooling, and ejection of work pieces or debris. Compressed air as a main utility within industrial facilities, account for more than 10 percent of energy consumption [5]. A